Fish Communities of the Vermilion River Watershed: Comparison of the Main Channel and Tributaries[1]

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ABSTRACT. **The Vermilion River watershed was the focus of a fish community survey from October 1995 through May 1996. Fish communities were sampled with a backpack electrofisher and a kick seine. A total of 8,005 individuals were collected representing 9 families, 49 species and at least 2 hybrids. Stoneroller minnows (*Campostoma anomalum*) were the most abundant species in the main channel followed by bluntnose minnows (*Pimephales notatus*), rainbow darters (*Etheostoma caeruleum*), then striped shiners (*Notropis chryocephalus*). Tributaries were dominated by creek chubs (*Semotilis atromaculatus*), stoneroller minnows, and bluntnose minnows. Fish species richness was greater in the main channel than in tributaries. Also, there were greater proportions of insectivorous fishes and species intolerant and moderately intolerant to pollution in the main channel. Generalists and pollution tolerant species dominated the tributaries. This pattern illustrates the importance of considering data from these habitats separately when attempting to assess the quality of fish communities or develop management strategies.**

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INTRODUCTION

Fish distribution and abundance in streams are affected by a wide range of physical and biological factors which may influence fish communities at several geographic scales. Microhabitat features such as stream depth, flow rate, substrate type, and the presence of cover can influence fish distributions (Angermeier 1987). Stream communities are complex, and associations between stream fishes and habitat features may vary considerably among different river systems, among reaches within the same river system, or even within the same stream location from year to year (Angermeier 1987). Fish species diversity has been positively correlated with habitat complexity (Gorman and Karr 1978, Schlosser 1982). Pool development and depth are among the most significant habitat attributes affecting stream fishes, but the presence of cover is also significant (Leopold and others 1964, Sheldon 1968, Evans and Noble 1979, Schlosser 1982).

Despite the influences of microhabitat variation on fish assemblages, streams of similar size tend to have very similar fish communities (Kuehne 1962, Whiteside and McNatt 1972, Lotrich 1973), and stream order may be a useful ecological concept (Lotrich 1973). In general, stream order is positively correlated with fish species richness and diversity (Kuehne 1962, Whiteside and McNatt 1972, Lotrich 1973). This increase in richness and diversity is usually due to the addition of new species at higher stream order, and not species replacement (Kuehne 1962, Whiteside and McNatt 1972, Lotrich 1973). In rivers that are subjected to heavy pollution, these trends in species richness and diversity break down (Tramer and Rogers 1973).

Fish communities have been used extensively as a method for studying the water quality of Ohio rivers (Ohio EPA 1987, 1989). This study was undertaken to determine the species composition of the Vermilion River watershed, and to aid in the development of conservation efforts. We also investigated differences among fish communities within tributaries and the main channel of the Vermilion River watershed.

MATERIALS AND METHODS

Study Location

The Vermilion River drains an area of approximately 680 km^2 as it flows through Ashland, Richland, Huron, Erie, and Lorain counties before emptying into Lake Erie. Unlike many rivers in northern Ohio, there has been relatively little agricultural, residential, and industrial development along much of the Vermilion River. This can largely be attributed to the steep shale cliffs and loose sediment surrounding the river. Also, a large portion of the floodplain and land adjacent to the river in Lorain County is protected as Lorain County Metro Parks Preserves.

Sampling Procedure

Sampling was conducted primarily with a Smith-Root model 12A backpack electrofisher operated at 300 volts with a POW setting of I, 5. Electrofishing was supplemented with kick seining in several riffle areas, using a 6.0 x 1.2 m seine, to obtain a more representative sample of riffle species that are under sampled during electrofishing. Sampling was conducted at 10 sites in the main channel of the Vermilion River and 11 sites on 7 tributaries (Table 1) Sampling occurred between October 1995 and May 1996, with most sampling concentrated in October, November, April, and May. Sampling was only conducted when river levels were close to normal levels. Repeated sampling occurred at 5 sites in Lorain County (4 in the main channel and one tributary), but most sampling areas were covered only once. Sites were

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TABLE 1

Location, stream order, dates, and sample effort at sites in the Vermilion River watershed. Sample dates between October 1995 and May 1996.

Bridge Location	Stream	Stream Order	Sample Dates	Sample Distance (m)[1]	Total Sample Effort
North Ridge Rd	Vermilion R	4 (M)	10 Oct, 16 Oct, 20 Oct 28 Apr, 9 May, 20 May, 21 May	100	7587s, 60 kick seines
SR 113	Vermilion R	4 (M)	3 Oct, 5 Oct, 11 Oct	275	1650s
Garfield Rd	Vermilion R	4 (M)	5 Oct, 11 Oct, 19 Oct, 1 Dec	200	1700s, 60 kick seines
Vermilion Rd	Chance Ck	2 (T)	10 Oct, 29 Apr, 6 May	1000	7686s
SR 20	Vermilion R	4 (M)	19 Oct	40	20 kick seines
Green Rd 1	Frankenburg Ck	2 (T)	8 Oct	150	850s
Green Rd 2	East Fork	3 (T)[2]	8 Oct	200	1300s
Barid Rd	East Fork	2 (T)	10 Oct	100	1450s
Dean Rd	Vermilion R	4 (M)	20 Oct	40	20 kick seine
Auster Rd	Vermilion R	4 (M)	22 Oct	150	1018s
Chenango Rd	Vermilion R	3 (M)	22 Oct	200	1041s
Zenobia Rd 1	Unnamed A	2 (T)	1 Nov	450	2554s
Zenobia Rd 2	Vermilion R	3 (M)	1 Dec	200	1500s
303A	Unnamed B	2 (T)	25 Feb	100	2000s
Cook Rd 2	East Branch	2 (T)	12 Apr	200	1087s
St. John Rd	Unnamed B	2 (T)	12 Apr	200	1082s
Derussy Rd	Indian Ck	2 (T)	11 Apr	250	1531s
Zenobia Railroad	Unnamed B	1 (T)	11 Apr	400	1900s
Leroy Rd	East Branch	3 (T)[2]	12 Apr	200	1127s
Cook Rd	Vermilion R	3 (M)	11 Apr	200	1008s
Peaseley Rd	Vermilion R	4 (M)	6 May, 22 May	800, 200	4700s

[1]Sample distances given in meters sampled per day.
[2]Two third order sites were considered as tributaries due to the size of the channel relative to other third order sampling sites.
M = mainstem, T = tributary.

located at bridges, and approximately 40-60 minutes of sampling was conducted upstream for several hundred meters. However, the site at Chance Creek and two main channel sites (one beginning about 50 m upstream and one that ended several river kilometers downstream of Chance Creek) were sampled for approximately one river kilometer (Table 1).

After collections were made, fish were counted and returned to the river. Voucher specimens were taken of species with unknown identities and were identified according to Trautman (1981). Identifications were verified at the Cleveland Museum of Natural History and reference specimens have been placed in the research collection.

River orders were determined using 1:24,000 US Geological Survey topographic maps.

RESULTS

We collected a total of 8,005 individuals representing 9 families, 49 species, and at least 2 hybrids (Table 2). Cyprinidae was the most diverse family in the river with 20 species and one hybrid. There were 8 species and at least 2 hybrids from Centrarchidae and 6 species of Percidae which were all darters. Stoneroller minnows (1,462, *Campostoma anomalum*) were the most abundant species followed by creek chubs (1,078, *Semotilis atromaculatus*), bluntnose minnows (1,026, *Pimephales notatus*), rainbow darters (833, *Etheostoma caeruleum*),

TABLE 2

Species found in the Vermilion River watershed during 1995-1996 surveys. Tolerance and feeding guild data after Ohio EPA (1989).

Common Name	Scientific Name	Stream Order	Overall	Main	Tributaries	Tolerance	Feeding Guild
Cyprinidae							
Striped Shiner	*Notropis chrysocephalus*	2, 3,4	731	553	178	I	
Sand Shiner	*Notropis stramineus*	3, 4	116	112	4	M	I
Rosyface Shiner	*Notropis rubellus*	2, 3, 4	104	102	2	I	I
Emerald Shiner	*Notropis atherinoides*	4	19	19	0		I
Spotfin Shiner	*Notropis spilopterus*	2, 3, 4	109	102	7		I
Silver Shiner	*Notropis photogenis*	4	34	34	0	I	I
N. Mimic Shiner	*Notropis volucellus*	3, 4	18	18	0	I	I
Common Shiner	*Notropis cornatus*	2, 4	3	2	1		I
Golden Shiner	*Notemigonus crysoleucas*	2	1	0	1	T	I
N. Redfin Shiner	*Notropis umbratilis*	1, 3	18	12	6		I
Bluntnose Minnow	*Pimephales notatus*	1, 2, 3, 4	1026	627	399	T	O
Silverjaw Minnow	*Ericymba buccata*	3, 4	60	58	2		I
Stoneroller Minnow	*Campostoma anomalum*	2, 3, 4	1462	852	610		H
N. Fathead Minnow	*Pimephales promelas*	2	4	0	4	T	O
Fathead x Bluntnose	*P. notatus* x *P. promelas*	1	1	0	1		
Creek Chub	*Semotilis atromaculatas*	1, 2, 3, 4	1078	71	1007	T	G
River Chub	*Nocomis micropogan*	4	40	40	0	I	I
Hornyhead Chub	*Nocomis biguttatus*	4	5	5	0	I	I
Northern Bigeye Chub	*Hybopsis amblops*	3, 4	208	204	4	I	I
Blacknose Dace	*Rhinichthys atratulus*	2, 3, 4	172	1	171	T	G
Common Carp	*Cyprinus carpio*	2, 4	37	11	26	T	O
Umbidae							
Central Mudminnow	*Umbra limi*	3	1	1	0	T	I
Percidae							
Rainbow Darter	*Etheostoma caeruleum*	2, 3, 4	833	796	37	M	I
Greenside Darter	*Etheostoma blennioides*	2, 3, 4	292	285	7	M	I
Johnny Darter	*Etheostoma nigrum*	1, 2, 3, 4	232	75	157		I
Fantail Darter	*Etheostoma flabellare*	2, 3, 4	311	309	2		I
Logperch	*Percina caprodes*	4	6	6	0	M	I
Blackside Darter	*Percina maeulata*	2, 3, 4	16	4	12		I
Cottidae							
Mottled Sculpin	*Cottus bairdi*	2, 3, 4	138	3	135		I
Catostomidae							
Hog Sucker	*Hypentelium nigricans*	2, 3, 4	156	142	14	M	I
White Sucker	*Catostomus commersoni*	1, 2, 3, 4	278	51	227	T	O
Golden Redhorse	*Moxostoma erythrurum*	2, 3, 4	38	36	2	M	I
Black Redhorse	*Moxostoma duquesnei*	2, 3, 4	17	16	1	I	I
Quillback Carpsucker	*Carpiodes cyprinus*	4	6	6	0		O
Centrarchidae							
Green Sunfish	*Lepomis cyanellus*	1, 2, 3, 4	53	26	27	T	I
Bluegill Sunfish	*Lepomis macrochirus*	2, 3, 4	55	44	11	P	I
Pumpkinseed Sunfish	*Lepomis gibbosus*	2, 4	4	3	1	P	I
Unknown Hybrids		4	9	9	0		
Rock Bass	*Ambloplites rupestris*	2, 3, 4	153	139	14		C
Smallmouth Bass	*Micropterus dolomieui*	2, 3, 4	86	80	6	M	C
Largemouth Bass	*Micropterus salmoides*	2, 4	12	9	3		C
Black Crappie	*Pomoxis nigromaculatus*	4	2	2	0		
White Crappie	*Pomoxis annularis*	4	1	1	0		
Clupeidae							
Gizzard Shad	*Dorosoma cepedianum*	4	14	14	0		O
Ictaluridae							
Yellow Bullhead	*Ictalurus natalis*	1, 3, 4	9	7	2	T	I
Brown Bullhead	*Ictalurus nebulosus*	1, 3	3	2	1	T	I
Black Bullhead	*Ictalurus melas*	3, 4	2	1	1	P	I
Channel Catfish	*Ictalurus punctatus*	4	3	3	0		
Stonecat Madtom	*Noturus flavus*	3, 4	24	24	0	I	I
Salmonidae							
Rainbow Trout	*Salmo gairdneri*	2	3	0	3		
Brown Trout	*Salmo trutta*	2	2	0	2		
Total Individuals			8005	4917	3088		
Total Species			49	45	36		

Tolerance: I = Intolerant, M = Moderately Intolerant, P = Moderately Tolerant, T = Tolerant.
Feeding Guild: I = Specialist Insectivore, O = Omnivore, H = Herbivore, G = Generalist, C = Carnivore.

and striped shiners (731, *Notropis chrysocephalus*).

Three species and one hybrid found during this study were not found in Ohio EPA surveys from May 6, 1987 to June 2, 1994 (Ohio EPA 1994). Hornyhead chubs (*Nocomis biguttatus*) were found at 2 Vermilion River sites in Lorain County, and 3 fathead minnows (*Pimephales promelas*) were found in Chance Creek (Lorain County). One fathead minnow and a fathead minnow x bluntnose minnow hybrid was found in a small tributary in southern Huron County. Finally, 2 large adult male brown trout (*Salmo trutta*) were found in Chance Creek.

Species richness was much higher in the main channel than in tributaries (Student's *t*-test, $p < 0.01$). An average of 23.0 (sd = 9.0) species were collected at each main channel site compared to 10.1 (sd = 4.9) in tributaries. Overall, 45 species were collected during electrofishing in the main channel and 37 in tributaries (Table 1). No unique species were collected during seining. Species abundances in the two areas differed markedly (Table 2). Creek chubs, for example, were the dominant species in tributaries but ranked fifteenth in the main channel. Rainbow darters showed the opposite pattern as they were the second most abundant species in the main channel, but ninth in the tributaries.

Main channel/tributary differences are further illustrated by the paired sample of Chance Creek and the Vermilion River site (Peasley Rd) which began just upstream of the confluence with Chance Creek. Sample effort and distance were equivalent, but a larger number of individuals were found in the tributary (1,340) than in the Vermilion River (549). Despite this, species richness was much higher in the main channel, which had 37 species compared to 17 in Chance Creek.

Species richness increased with stream order. The number of species in first-, second-, third-, and fourth-order streams were 8, 30, 29, and 44, respectively. The average numbers of species at stream sites were 8.0, 10.8, 15.6, and 23.4. Third-order tributaries had fewer species and average species per site (20 and 14.6, respectively) than third-order sites in the main channel (27 and 16.7, respectively).

Pollution tolerance categories were available for 29 species collected during this study (Table 2). The fish communities of main channel and tributary sites differed with regard to pollution tolerance. In tributaries, the majority of individuals of known tolerance category were either moderately tolerant or tolerant ($\chi^2 = 1978.7$, df = 3, $p << 0.001$). In contrast, main channels contained more intolerant and moderately intolerant individuals (Table 3). Although there is a trend towards more moderately intolerant and intolerant species in the main channel, this difference is not significant (Table 4, $\chi^2 = 1.9$, df = 3, $p = >0.1$). Neither of the above results are changed if only individuals from electrofishing are used in the sample.

Feeding guild categories were available for 45 species comprising 7,987 individuals (Table 2). Insectivores dominated the assemblage with 73.3% of species and 45.8% of individuals. There was a significant difference between the main channel and tributaries in the number of individuals representing each guild (Table 5, $\chi^2 = 2501.3$, df = 4, $p << 0.001$). Insectivorous individuals and carnivores were much better represented in the main channel. Omnivores, herbivores, and generalists were more numerous in tributaries. There was no significant difference in the species proportions of feeding guilds between main channel and tributary sites (Table 6, $\chi^2 = 0.2$, df = 4, $p = >0.9$).

TABLE 3

Number of individuals falling into each pollution tolerance category in the main channel and tributaries. There are significantly more intolerant and moderately intolerant individuals in the main channel ($\chi^2 = 1978.7$, df = 3, $p << 0.001$).

	Intolerant	Mod. Intolerant	Mod. Tolerant	Tolerant	Total
Main Channel	442	1494	49	888	2873
Tributaries	8	70	14	1865	1957
Combined	450	1564	63	2753	4830

DISCUSSION

This study shows longitudinal zonation of fish communities similar to that reported in other stream systems (Kuehne 1962, Whiteside and McNatt 1972, Lotrich 1973). One difference with previous studies was the number of species found in the first-order stream site. Although the Zenobia Railroad site is prone to drying at certain times of the year, 8 species were found (Table 2). With much more extensive sampling of first-order streams Whiteside and McNatt (1972) only found 6 species, and Kuehne (1962) only found creek chubs in first-order streams.

The larger number of species in second-order streams compared to third-order streams was likely due to the greater sample of second-order streams. This is supported by the higher average number of species per site in third-order streams. Although sample size is too small for adequate comparisons, there is an interesting trend toward fewer species in third-order tributaries

Table 4

Number of species falling into each pollution tolerance category in the main channel and tributaries. There is no significant difference in the distribution of pollution tolerances between the main channel and tributaries ($\chi^2 = 1.9$, df = 3, $p = >0.1$).

	Intolerant	Mod. Intolerant	Mod. Tolerant	Tolerant	Total
Main Channel	8	7	3	9	27
Tributaries	3	6	3	10	22
Combined	8	7	3	11	29

TABLE 5

Number of individuals falling into each feeding guild category in the main channel and tributaries. There are significantly more insectivorous individuals and carnivores in the main channel and more generalists in the tributaries ($\chi^2 = 2501.3$, $df = 4$, $p << 0.001$).

	Insectivore	Omnivore	Herbivore	Generalist	Carnivore	Total
Main Channel	3044	706	863	74	225	4912
Tributaries	616	656	610	1177	25	3084
Combined	3660	1362	1473	1251	250	7996

when compared to the main channel. If this difference is real, it is likely due to the greater volume of water flowing through the main channel, and greater number of microhabitats available.

As in previous studies (for example, Lotrich 1973), most of the increase in species diversity with river order was attributable to species additions. Only 7 species and 1 hybrid were restricted to stream orders lower than fourth. Six of these species and the hybrid were represented by less than 5 individuals and the sixth species by less than 20, so it is unclear if this restriction to lower-order streams is real. At least 2 of these, the rainbow and brown trout, were found in a tributary near Lake Erie, and had most likely passed through a fourth-order stream to reach this tributary to spawn.

The results of this study suggest that the Vermilion River is a high quality stream. Unfortunately, data collection was not appropriate for calculation of indices of biological integrity (IBI) (Ohio EPA 1987). However, the Vermilion River displays traits, such as the presence of longitudinal zonation of fish communities and the abundance of darters and intolerant species, that are indicative of clean-water streams.

This study also suggests that fish community data from main channel and tributary sites should be segregated when assessing data from an entire watershed. If data was lumped, it might appear that the Vermilion River system had poorer water quality than if main channel sites were analyzed separately. Main channel sites show a higher proportion of insectivores and intolerant individuals. The higher proportions of generalist and pollution tolerant individuals in tributaries could be a product of degraded water quality in tributaries, but this seems unlikely since main channel sites downstream of tributary sites do not indicate water quality degradation. It is possible that this result is an effect of the pollution tolerances of species that are predominantly found in tributaries. For example, creek chubs (pollution tolerant), show a preference for lower-order streams and can dominate these assemblages, even in apparently high quality streams (Kuehne 1962, Trautman 1981).

Using proportions of species in each pollution tolerance or feeding guild category may provide a better indicator of water quality than using the proportion of individuals. Data for both pollution tolerances and feeding guilds are less variable between main branch sites and tributaries. Also, large abundances of species common to a habitat due to life history, rather than degraded water quality, will have less of an impact on the data.

TABLE 6

Number of species falling into each feeding guild in the main channel and tributaries. There is no significant difference in the distribution of feeding guilds between the main channel and tributaries ($\chi^2 = 0.2$, $df = 4$, $p = >0.9$).

	Insectivore	Omnivore	Herbivore	Generalist	Carnivore	Total
Main Channel	31	5	1	2	3	42
Tributaries	24	4	1	2	3	34
Combined	32	6	1	2	3	44

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